CHM113 General Chemistry I (Dr. Jen) Key

Molar Conversions Practice

1) In 68 grams of copper (II) hydroxide, $Cu(OH)_2$ $M_{Cu(OH)_2} = (1 \times 63.546\ g/mol) + (2 \times 15.999\ g/mol) + (2 \times 1.0079\ g/mol) = 97.560\ g/mol$ (3 s.f.; 5 s.f.; 4 s.f.; 3 s.f.)

a) How many moles are there?

$$68\ g\ Cu(OH)_2 \times \frac{1\ mol\ Cu(OH)_2}{97.560\ g\ Cu(OH)_2} = 0.69700 = \boxed{0.70\ moles\ Cu(OH)_2}$$

(2 s.f.; 5 sig. fig.; 2 sig. figs.)

b) How many molecules are there?

$$68\ g\ Cu(OH)_2 \times \frac{1\ mol\ Cu(OH)_2}{97.560\ g\ Cu(OH)_2} \times \frac{6.02 \times 10^{23}\ molecules\ Cu(OH)_2}{1\ mol\ Cu(OH)_2} = \boxed{4.2 \times 10^{23}\ molecules\ Cu(OH)_2}$$

(2 s.f.; 5 s.f.; conversion factor ∴ doesn't count for s.f.; 2 s.f.)

c) What is the mass of hydroxide ions? $M_{OH^-} = (1 \times 15.999\ g/mol) + (1 \times 1.0079\ g/mol) = 17.0069\ g/mol$ → 17.007 g/mol → so

$$68\ g\ Cu(OH)_2 \times \frac{1\ mol\ Cu(OH)_2}{97.560\ g\ Cu(OH)_2} \times \frac{2\ mol\ OH^-}{1\ mol\ Cu(OH)_2} \times \frac{17.007\ g\ OH^-}{1\ mol\ OH^-} = 23.7 = \boxed{24\ g\ OH^-\ ions}$$

(2 s.f.; 5 s.f.; 6 s.f.)

2) In 3.3 moles of potassium sulfide, K_2S $M_{K_2S} = (2 \times 39.0983\ g/mol) + (1 \times 32.066\ g/mol) = 110.263\ g/mol$ (4 s.f.; 3 s.f.; 3 s.f.)

a) How many grams are there?

$$3.3\ mol\ K_2S \times \frac{110.263\ g\ K_2S}{mol\ K_2S} = 363.866 = \boxed{360\ g\ K_2S \text{ -or- } 3.6 \times 10^2\ g\ K_2S}$$

(2 s.f.; 2 s.f.)

b) How many potassium ions are there?

$$3.3\ mol\ K_2S \times \frac{6.02 \times 10^{23}\ molecules\ K_2S}{1\ mol\ K_2S} \times \frac{2\ K^+\ ions}{1\ molecule\ K_2S} = 3.97 \times 10^{24} = \boxed{4.0 \times 10^{24}\ K^+\ ions}$$

(2 s.f.; counting so don't count for s.f.; 2 s.f.)

c) What is the mass of sulfide ions?

$$3.3\ mol\ K_2S \times \frac{1\ mol\ S^{2-}}{1\ mol\ K_2S} \times \frac{32.066\ g\ S^{2-}}{1\ mol\ S^{2-}} = 105.8 = \boxed{110\ g\ S^{2-}\ ions \text{ -or- } 1.1 \times 10^2\ g\ S^{2-}\ ions}$$

(2 s.f.; 5 s.f.; from P.T. Recall, e⁻s don't weigh much so don't affect the mass; 26. s.f.)

3) In 1.2 kg grams of ammonia, NH_3, approximate mass relative to the atom to any significant amount so can use atomic mass to individual ion mass

$M_{NH_3} = (1 \times 14.00674\ g/mol) + (3 \times 1.0079\ g/mol) = 17.0304\ g/mol$ (5 s.f.; 4 s.f.; 4 s.f.)

a) How many moles are there?

$$1.2\ kg\ NH_3 \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ NH_3}{17.0304\ g\ NH_3} = 7.046 \times 10^{-5} = \boxed{7.0 \times 10^{-5}\ mol\ NH_3}$$

(2 s.f.; doesn't count; 6 s.f.; 2 s.f.)

b) How many hydrogen atoms are there?

$$1.2\ kg\ NH_3 \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ NH_3}{17.0304\ g\ NH_3} \times \frac{6.02 \times 10^{23}\ molecules\ NH_3}{1\ mol\ NH_3} \times \frac{3\ H\ atoms}{1\ molecule\ NH_3} = \boxed{1.3 \times 10^{20}\ H\ atoms}$$

*Note: Not diatomic b/c in a molecule not elemental state

-OR-

$$7.0 \times 10^{-5}\ mol\ NH_3 \times \frac{3\ mol\ H}{1\ mol\ NH_3} \times \frac{6.02 \times 10^{23}\ H\ atoms}{1\ mol\ H} = \boxed{1.3 \times 10^{20}\ H\ atoms}$$

* A good way to check your work!

$\mathcal{M} = (19 \times 12.011\ g/mol) + (28 \times 1.0079\ g/mol) + (2 \times 15.999\ g/mol) = 288.429\ g/mol$ (3 s.f.; 4 s.f.; 3 s.f.; 3 s.f.)

4) A sample of $C_{19}H_{28}O_2$ contains 3.88×10^{21} hydrogen atoms.

a) How many carbon atoms does it contain?

3.88×10^{21} H atoms $\times \frac{19\ C\ atoms}{28\ H\ atoms} = 2.63 \times 10^{21}$ C atoms (3 s.f.)

(28 H atoms from chemical formula: $C_{19}H_{28}O_2$; counting so doesn't count for s.f.)

b) How many molecules of $C_{19}H_{28}O_2$ are there?

3.88×10^{21} H atoms $\times \frac{1\ molecule\ C_{19}H_{28}O_2}{28\ H\ atoms} = 1.39 \times 10^{20}$ molecules $C_{19}H_{28}O_2$ (3 s.f.)

(counting so no s.f.)

c) What is the mass of the sample, in milligrams?

(6 s.f.)

3.88×10^{21} H atoms $\times \frac{1\ molecule\ C_{19}H_{28}O_2}{28\ H\ atoms} \times \frac{1\ mol\ C_{19}H_{28}O_2}{6.02 \times 10^{23}\ molecules\ C_{19}H_{28}O_2} \times \frac{288.429\ g\ C_{19}H_{28}O_2}{1\ mol\ C_{19}H_{28}O_2} \times \frac{1000\ mg}{1\ g} = 66.39 =$ (3 s.f.)

66.4 mg $C_{19}H_{28}O_2$

- OR -

3.88×10^{21} H atoms $\times \frac{1\ mol\ H}{6.02 \times 10^{23}\ H\ atoms} \times \frac{1\ mol\ C_{19}H_{28}O_2}{28\ mol\ H} \times \frac{288.429\ g\ C_{19}H_{28}O_2}{1\ mol\ C_{19}H_{28}O_2} \times \frac{1000\ mg}{1\ g} =$ → 66.4 mg $C_{19}H_{28}O_2$

5) Given, 42 g of $NaHCO_3$ < 1.5 mol CO_2 < 6.0×10^{24} Ne atoms

a) Rank in order of increasing number of atoms

$NaHCO_3$: $42\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.007\ g\ NaHCO_3} \times \frac{6.02 \times 10^{23}\ molecules}{1\ mol\ NaHCO_3} \times \frac{6\ atoms}{1\ molecule} = 1.8 \times 10^{24}$ atoms

$\mathcal{M}_{NaHCO_3} = (1 \times 22.98977\ g/mol) + (1 \times 1.0079\ g/mol) + (1 \times 12.011\ g/mol) + (3 \times 15.999\ g/mol) = 84.007\ g/mol$

CO_2: $1.5\ mol\ CO_2 \times \frac{6.02 \times 10^{23}\ molecules\ CO_2}{1\ mol\ CO_2} \times \frac{3\ atoms}{1\ molecule} = 2.7 \times 10^{24}$ atoms

$1.8 \times 10^{24} < 2.7 \times 10^{24} < 6.0 \times 10^{24}$ so

- Alternatively you could convert to moles & compare.

b) Rank the first two in order of number of oxygen atoms

$42\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.007\ g\ NaHCO_3} \times \frac{3\ mol\ O}{1\ mol\ NaHCO_3} = 1.4998 = 1.5$ mol O atoms in $NaHCO_3$

(O in a molecule not an element ∴ not diatomic)

$1.5\ mol\ CO_2 \times \frac{2\ mol\ O}{1\ mol\ CO_2} = 3.0$ mol O atoms in CO_2

→ 1.5 mol CO_2 > 42 g $NaHCO_3$

* Note: You can also convert moles → # atoms w/ Avogadro's # & compare there too the answer for ranking will be the same

6) The concentration of a sample of C_2H_3Cl is 2.0×10^{-6} g/L.

$\mathcal{M} = (2 \times 12.011\ g/mol) + (3 \times 1.0079\ g/mol) + (1 \times 35.453\ g/mol) = 62.498\ g/mol$

a) How many moles are in 1 liter?

$1\ L \times \frac{2.0 \times 10^{-6}\ g\ C_2H_3Cl}{1\ L} \times \frac{1\ mol\ C_2H_3Cl}{62.498\ g\ C_2H_3Cl} = 3.2 \times 10^{-8} = 3 \times 10^{-8}$ moles C_2H_3Cl (1 s.f.; 2 s.f.; 5 s.f.; 1 s.f.)

b) How many molecules are in 2 liters?

$2\ L \times \frac{2.0 \times 10^{-6}\ g\ C_2H_3Cl}{1\ L} \times \frac{1\ mol\ C_2H_3Cl}{62.498\ g\ C_2H_3Cl} \times \frac{6.02 \times 10^{23}\ molecules\ C_2H_3Cl}{1\ mol\ C_2H_3Cl} = 3.85 \times 10^{16} = 4 \times 10^{16}$ molecules of C_2H_3Cl (1 s.f.; 2 s.f.; 5 s.f.; × doesn't count; 1 s.f.)